United Nations E/CN.17/2001/3

Economic and Social Council

Distr.: General
13 December 2000

Original: English

Commission on Sustainable Development
Ninth session
16-27 April 2001

Transport

Report of the Secretary-General

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I. Introduction

1. Transport is considered in Agenda 21 in several chapters, including chapter 9 on atmosphere and chapter 7 on human settlements. While note is taken of the essential and positive role that transport plays in economic development, it is recommended that, as a source of atmospheric emissions, there is need for more effective design and management of traffic and transport systems. Specific goals and activities relating to transport are recommended, including that Governments, with the cooperation of the United Nations, develop and promote, as appropriate, cost-effective, more efficient and less polluting transport systems; facilitate access to resource-efficient and less polluting transport technologies; and encourage the use of transport modes that minimize adverse effects on the atmosphere.

2. At its nineteenth special session, held in 1997, the General Assembly reaffirmed that the transport sector and mobility in general have an essential and positive role to play in economic and social development, and noted that transportation needs will undoubtedly increase. In its consideration of the programme of work of the Commission on Sustainable Development, it was decided that energy/transport would be a major theme of the Commission's ninth session, to be held in 2001. The present report has been prepared for these deliberations, with input from United Nations agencies and regional commissions working in the field of transport as well as the World Bank. Detailed information about the atmosphere can be found in the report of the Secretary-General on protection of the atmosphere (E/CN.17/2001/2). The energy aspects of transport are dealt with in the report of the Secretary-General entitled "Energy and sustainable development: options and strategies for action on key issues" (E/CN.17/ESD/2001/2), which was prepared for the second session of the Ad Hoc Open-Ended Intergovernmental Group of Experts on Energy and Sustainable Development.

3. The issue of transport was considered at the fourth and fifth sessions of the Commission, and its recommendations were endorsed by the General Assembly at its nineteenth special session, in 1997. The General Assembly has adopted a number of resolutions aimed at the transport sector, including policy recommendations for the achievement of sustainable development, with a specific reference to improving energy efficiency in the transport sector using a broad spectrum of policy instruments and efficiency standards. At its second session, the Commission took note of the severe impacts of human exposure to lead, and encouraged further efforts to reduce human exposure to lead. At its third session, it called on interested countries to develop action plans with a view to phasing out or reducing the use of lead in gasoline. At its nineteenth special session, the General Assembly pointed to the need for accelerating the phase-out of leaded gasoline as soon as possible. The Committee for Energy and Natural Resources for Environment and the former Committee on New and Renewable Sources of Energy and on Energy for Development have considered the issue of transport in terms of both energy development and the efficient utilization of energy, as well as in terms of the role of transport as a major energy-consuming sector.

4. As part of preliminary work undertaken to prepare for the ninth session of the Commission, the United Nations, together with the World Bank, held an international round table on transport energy efficiency and sustainable development in Cairo in December 1999. It considered a range of issues related to energy efficiency in the transport sector, including alternative fuel vehicles, public transport options, fuel cell technology, options for cleaner fuels, emissions standards and institution-building, including information infrastructure. The round table called for specific measures to be undertaken at the international, regional and national levels to eliminate leaded gasoline, reduce emissions and move towards a transport system in line with sustainable development goals.[1] It also endorsed the Global Initiative on Transport Emissions (GITE) (see annex), which was subsequently launched by the United Nations and the World Bank to address the problem of transport emissions within the framework of sustainable development. The initiative includes assistance to countries and regions to develop and implement up-to-date transport information collection, compiling and analytical methodologies, encouragement of private/public partnerships to promote the transfer of cleaner technologies, and assistance to developing countries in promoting transport projects to meet sustainable development goals.

5. In the 1992 United Nations Framework Convention on Climate Change, industrialized countries and countries of Central and Eastern Europe

agreed to take measures to limit their greenhouse gas emissions with the aim of returning, individually or jointly, to their 1990 levels by the end of 2000. Parties are required to cooperate in developing, applying and transferring technology that reduces or prevents emissions of greenhouse gases, and to assist developing countries. The Kyoto Protocol of December 1997 established legally binding commitments on industrialized countries to reduce their emissions of a basket of greenhouse gases by slightly more than 5 per cent between 2008 and 2012, and flexible mechanisms to promote cost savings have been included. Details are under consideration and the Protocol has not yet entered into force.

6. The Global Plan of Action adopted by the United Nations Conference on Human Settlements (Habitat II), held in Istanbul in 1996, calls for a number of actions with respect to urban transport that would promote sustainable development goals, including the elimination of leaded gasoline.

II. Transport and sustainable development

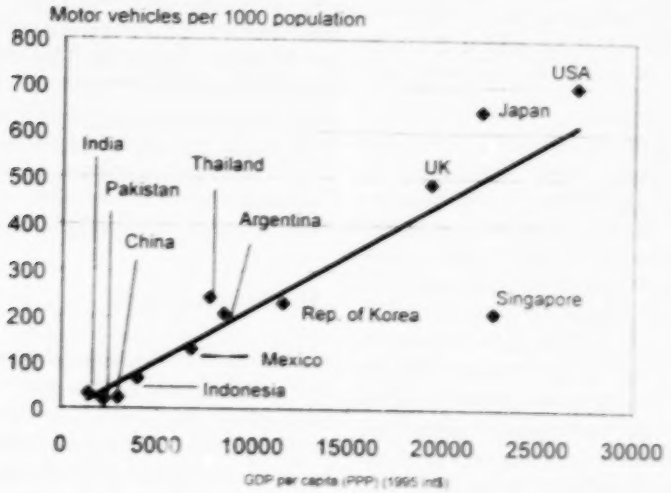
7. The ability to transport goods and services is a prerequisite for economic growth and development and contributes significantly to the gross domestic product (GDP) of most countries, but emissions associated with vehicle use cause environmental and health problems in many of the world's major cities and contribute to global environmental problems. More than 95 per cent of the fuel used in the transport sector is petroleum-based, and its emissions contribute to global levels of greenhouse gases, most notably carbon dioxide (CO_2), as well as local pollutants, such as lead, fine particulate matter (PM), nitrogen oxides (NO_x) and sulphur oxides (SO_x). Activity in the transport sector and resultant pollutants are expected to grow as economies grow and as population growth and urbanization continue. Moreover, accidents and congestion associated with unsustainable transport systems represent costs to society and thus adversely affect sustainable development.

8. Increases in per capita income and growth in population in the developing world have contributed to the rising demand for transportation services and associated energy. Growth in developing countries has often been marked by improvement in the physical infrastructure during the past 25 years, including transportation systems. Some developing countries now boast modern road and air transport facilities, while many have modern ports and improved sea access. The figure illustrates the relationship between per capita income and ownership of motor vehicles, one measure of transport demand, in various industrialized and developing countries. Of the high-income countries included, only Singapore has a relatively low per capita motor vehicle ownership mainly due to limitations on vehicle ownership, aggressive support of public transport and high taxes on automobiles. In many countries, especially industrialized countries, the transport sector is a major contributor to economic performance. It accounts for 7 per cent of GDP in Organisation for Economic Cooperation and Development (OECD) countries and provides for more than 10 per cent of total employment.

9. Meeting the demand for transport involves high costs, bearing heavily on public spending, business expenditures and family budgets, and affects low-income family budgets in particular, adding to the poverty burden. However, transport investment decisions can promote social development if they are undertaken in tandem with land-use regulations that limit urban sprawl and manage urban growth with housing policies attentive to the transport needs of the poor. Many Asian and some Latin American cities have located higher density low-income housing and excellent public transport systems near each other to maximize accessibility for lower-income families.

10. The poor on average travel less far and less frequently but spend more time travelling than higher-income groups. This phenomenon has been noted in studies of South America, Africa and North America. Motor vehicles are prohibitively expensive for the vast majority of poor people, who depend on public transportation systems, when available and affordable, bicycles, animal power and walking. Access to transport services by the poor affect the cost of basic necessities and services necessary for healthy living and the ability to earn income. Both are adversely affected when access to transport services is limited.[2] Also, road accidents are more likely to affect the poor.

GDP per capita and motor vehicle ownership in selected countries, 1995



11. In many countries, transport systems may play a role in promoting gender equality, though attention to mobility needs of women are rarely considered by existing transport policies.[3] While men's travel is more frequently centred around commuting to work, women's travel is often focused on meeting household needs, such as collecting water and fuel, removing solid waste and taking children to school and health facilities. Women's lack of physical mobility is an important obstacle to employment, income generation, education and participation in civil society. The needs of women are important when deciding upon transport infrastructure investments, training and public awareness programmes and incentive programmes.

12. Many countries are hampered in their attempts to improve the quality of transport systems by a lack of adequate transport and related data and information on which to assess and analyse problems, needs and solutions. There is a need to improve capacity in many countries to gather, compile and analyse data using reliable and consistent methodologies and modern information technologies.

A. Regional trends

13. In OECD countries, transport contributes to socio-economic well-being and is an important sector of the economy. The motor vehicle industry and transport equipment industry are particularly significant. CO_2 emissions from transport increased considerably from 1971 to 1990, and are expected to continue to increase during the next 20 years. Per capita emissions of CO_2 in total and from transport are also highest in the OECD countries. Currently, industrialized countries are responsible for 57 per cent of global CO_2 emissions from transport, with 32 per cent coming from North America.[4] In addition, industrialized countries account for 62 per cent of carbon monoxide (CO) and 59 per cent of NO_x emissions but those levels are expected to decrease by 50 per cent and 8 per cent, respectively, in this decade. OECD countries have agreed on a number of measures to reduce transboundary air pollution and promote sustainable transport.

14. Transport is also an important economic sector in the countries in transition, and has recently been a factor in opening up peripheral and isolated European

countries. In Central and Eastern Europe, transport emissions were stable from 1989 to 1994. Though private motor vehicle use increased dramatically at the expense of public transport, this was countered by the replacement of old, highly polluting cars with two-stroke engines and of inefficient buses and trucks with less polluting vehicles, as well as by economic recession.

15. Africa, with 53 independent countries of varying cultures and sizes as well as rough and dangerous terrain, has considerable agricultural and mineral potential but needs a viable transport system to facilitate the export of goods to markets. There are 15 landlocked countries, and travel is difficult and expensive in many areas, including tropical areas. Access by villagers and rural area dwellers to modern systems of transport is very limited. Many African countries have focused some attention on air transport given its flexibility in promoting economic development and integration for landlocked and semi-landlocked countries. Motor vehicle ownership rates average about 10 vehicles per thousand people, though there is generally a wide variation between urban and rural areas. On average, 3.5 per cent of the population use bicycles, and the majority of trips are made by walking. The economic impact of the transport sector in Africa is estimated at 3 per cent of GDP.

16. Asia has undergone rapid motorization in recent years, and enjoys a diversity of public transit and para-transit options (that is, private, commercial multiple passenger vehicles or transport services that are not private cars or taxis, public transit vehicles or services), especially in urban areas. Emissions from transport, including CO_2, are expected to increase significantly in the first half of the twenty-first century as economies grow and private vehicle use increases. Socio-economic development in China and India, in particular, are expected to contribute to rising demand for transport services in the region.

17. The countries of Western Asia[5] have a well developed road system and rely heavily on the automobile for intercity and regional transport. As in other regions, transport plays a major role in development and transport demand has increased at a greater pace than GDP in recent years. It has also facilitated migration from rural areas to urban areas. The socio-economic benefits provided by the various transport projects include increased access to markets for local products, access to new employment centres and passage to health and recreation centres. In general, improved transport is considered as a means for strengthening local economies.

18. In Latin America, many of the large municipal bus systems are privately owned and operated under government concession agreements, and many cities have both public and private bus systems. Some cities, such as Bogota, have undertaken aggressive policies to reduce car use and dependency within city limits. Emissions from transport on a per capita basis have increased from 1971 to 1995 but are still lower than those found in industrialized regions.

B. Urbanization

19. In 1995, the United Nations estimated that 46 per cent of the world's population (2.6 billion) resided in urban areas, and this figure is expected to increase to 50 per cent in 2006 and become more than 60 per cent by 2030. Moreover, by 2030, 80 per cent of the world's urban population will be located in developing countries. The rapid pace of urbanization means that not only are more people living and working in cities but also more people and more goods are making more trips in urban areas, often over longer and longer distances. How cities — especially rapidly growing cities in developing countries — meet the increased demand for urban transport can have profound implications for the global environment and the economic productivity of human settlements. Transport infrastructure decisions have long-run impacts on how an urban area grows, where residents and industries locate and whether an urban centre remains viable as a place to live and work.

20. Along with emissions of local pollutants, which are a growing problem in many urban areas and are shown in table 2 for selected cities, transport exerts a demand on land for the construction of infrastructure. The construction of transport infrastructure often disrupts neighbourhoods, relocating urban residents to the periphery and increasing their travel distances and expenditures; decreases safety; degrades the amenity of public open spaces; and creates visual intrusions. Yet inadequate or unaffordable transport leads to excessive building and population densities, causing deterioration of local environments. Inadequate urban transport systems are also associated with congestion, increased incidents of accidents and adverse impacts on human health. Growing megacities are faced with many

obstacles to providing adequate transport services to the urban poor, who live in unplanned, peripheral settlements and cannot afford to pay for many basic services, including transportation. Smaller secondary cities face similar challenges but often receive far less attention by policy makers and the international community. Some urban areas have been successful in implementing policies to promote mass transit systems, encourage non-motorized transport, including walking, and discourage private car use. Notable successes have been achieved in Curitiba, Brazil, and Singapore.

C. Rural areas

21. Rural areas, especially those in developing countries, are often characterized by inadequate transport systems, making it difficult for agricultural goods to be taken to market places and hampering economic growth. Non-motorized transport predominates in many rural areas, with walking serving as a major transport mode for rural dwellers.

22. Many rural areas, including those in Africa, face obstacles in developing rural transport systems related to inappropriate instruments for financing and managing rural roads and other transport infrastructure; erratic and insufficient funding; lack of coordination; centralized decision-making; and unclear legal status of many rural roads. In many developing countries, national Governments are unable to share the burden with local communities and regional areas of high infrastructure costs associated with developing transport systems. Many developing countries have undertaken structural adjustment policies and privatization measures, which are expected to assist in eliminating urban biases of past policies, as well as policies specifically designed to promote rural economic growth. It is important that transport networks adequately serve rural areas for such policies and measures to be effective.

23. Rural areas of some industrialized countries have faced problems associated with lack of maintenance and upkeep of rural transport systems. For example, the Russian Federation has an estimated network of 700,000 kilometres of rural roads that, as a result of difficulties related to the transition period, lack of stable flow of funds, high design standards and poor quality of construction materials, is deteriorating rapidly. Problems in other industrialized countries related to maintenance of rural infrastructure, including bridges and railroad tracks, have also been noted. The preference of some countries to build new roads rather than maintain existing networks has resulted in the loss of transport networks.

D. Globalization

24. The pace of globalization is increasing and is expected to continue as innovations in information and communication technology are widely adopted, as international arrangements such as those of the World Trade Organization (WTO) are implemented and become more effective, and as policies to promote trade and development are adopted. Growth in world volume of trade was recorded at 9.2 per cent in 1997, 3.3 per cent in 1998, is estimated at 5.6 per cent in 1999 and will continue to increase significantly. Recent forecasts estimate growth of more than 8 per cent in 2000 and at 7.5 per cent in 2001. While Agenda 21 supports an open, multilateral trading system as contributing to sustainable development, it should be supported by sound environmental policies. Globalization is expected to result in an increased demand for transport services worldwide, in part to move raw materials and final goods from centres of production to markets. It will ultimately generate investment spending in transport infrastructure, especially in developing countries. Transport system decisions, including environmental, social and economic considerations, will be important in achieving overall sustainable development goals.

25. International trade requires the existence of a well functioning international transport system, including maritime transport, as well as viable transport systems at the national level, for countries to be able to fully participate and benefit. The existence of an efficient transport system is also a necessary condition for foreign direct investment (FDI). Many developing countries are improving their transport sectors to become more competitive in the global market and to increase their attractiveness to FDI, which can in turn enhance their participation in that market.

26. Electronic commerce (or E-commerce) is now a means of marketing products and services, placing orders, billing and, for a wide variety of products, a means of distribution. It has reduced time-lags associated with trade, allowing for transactions 24 hours a day and seven days a week. While accounting for only 4.5 per cent of total trade — or between $150

and 200 billion in 1998 — the estimated volume of E-commerce trade in 2000 is $377 billion. Projections indicate that it could account for 10 to 20 per cent of world trade by 2003. However, this growth will be skewed towards those countries with widespread electronic facilities and capabilities, mostly industrialized countries. The growth in E-commerce in developing countries will be hampered by a lack of telephone lines, electricity, affordable computers, education and literacy.

27. The implications of E-commerce for the transport industry are wide-ranging. There will probably be an integration of the global supply chain that will force structural changes on the industry. Transport services will become more integrated: the transport operator will become a multimodal operator with control over each of the modes and long-term relations with the terminals. Increased efficiency and lower costs imply greater demand for transport services, and while this will facilitate globalization it has important implications for sustainable development.

E. Consumer behaviour

28. The behaviour of consumers has played an important role in the success and failure of transport policies, and consumers as a group have been influential as a driving force behind certain government regulations and voluntary industry measures promoting sustainability in the transport sector. Consumer behaviour in many industrialized countries following the oil price increases of the 1970s and early 1980s led to the downsizing of automobiles and an increase in their fuel efficiency. Standards and regulation on vehicle efficiency enacted in the 1980s and 1990s in many countries enjoyed widespread public support, such as the corporate average fuel efficiency regulations in the United States. In many countries, consumer advocates have also been successful in promoting safety features in vehicles, such as seat belts and air bags. Although experts often point to economic incentives as a more cost-effective way to achieve sustainability goals in the transport sector, they are far less popular and many policy makers are reluctant to use them. Recent consumer dissatisfaction over gasoline taxes in Europe and increases in public transport fares in urban areas of Latin America point to difficulties in applying certain economic incentives.

29. It is important to take consumer behaviour into consideration when implementing policies and measures for promoting sustainability in the transport sector, and to recognize that they may be more effective if consumer groups are consulted as policies and measures are developed. Options available for policy makers can be broadly categorized as economic incentives, public investment and regulations, but their success will depend on how consumers react.

III. Environmental impact of transport systems

A. Global impacts

30. Almost all motorized transportation today involves the combustion of fossil fuels, which produces CO_2, the major greenhouse gas. The transport sector now accounts for about 21 per cent of global CO_2 emissions, and it is anticipated that that share will grow by 92 per cent by 2020, a growth unmatched by any other sector except power generation. The growing use of natural gas (methane) in the transport sector may contribute to greenhouse gas emissions since storage systems may leak. Nitrous oxide (N_2O) is the most potent of the greenhouse gases emitted by the transport sector (aside from fluorocarbons, which leak from air-conditioning systems). Efforts to reduce NO_x from motor vehicle use will reduce N_2O emissions, but most regulations focus primarily on nitric oxide (NO) and nitrogen dioxide (NO_2). Additional information on the atmosphere is found in the report of the Secretary-General on protection of the atmosphere (E/CN.17/2001/2).

B. Local impacts

31. Emissions from the transport sector other than GHGs include volatile organic compounds, soot, CO and SO_x, the most damaging of which are sulphur dioxide (SO_2), NO_x and lead. These by-products directly damage human health but they can also react in sunlight to produce sulphuric acid, sulphates and ozone, which also damage human health. Because many pollutants are concentrated in areas immediately near their emissions sources, exposure to local emissions from transport is largely a function not only of the amount of activity but also of population densities near large transportation corridors and the

number of people who regularly work along these roadsides, such as street merchants and construction crews. Both of these factors are more significant in developing countries.

32. The negative effects of lead are clear and well documented. Ingestion of lead aerosols has been linked to cardiovascular disease, premature death and behavioural and development problems among children. In the United States, the marginal costs to the United States economy of each 0.01 grams (g) of lead per litre of gasoline have been estimated at about US$ 17 million per year. A survey of urban air quality in 20 megacities by the World Health Organization and the United Nations Environment Programme (UNEP) in the early 1990s found that lead exposure was largely becoming a problem of developing country cities. Lead has been completely phased out in about 16 per cent of all countries, as table 1 shows. Some regions, however, are significantly more advanced in phasing out lead than others, and countries with low levels of allowable lead (under 0.15 g per litre) tend to be medium- or high-income countries. The situation in sub-Saharan Africa is of particular concern because of the high lead levels in gasoline; over one quarter of the countries have a standard of 0.84 g per litre, and the median allowed lead content is 0.64 g per litre, more than four times as high as the world median.

33. Emissions of particulate matter from the transport sector also contribute to local pollution. Particulate matter is associated with cardiopulmonary disease, cardiovascular disease, respiratory disease, lung cancer and other cancers. Fine particles are increasingly being identified as a source of health problems, more than coarse or large particles. They become lodged in the respiratory system and long-term symptoms do not dissipate when exposure is terminated. Nevertheless, in many countries, ambient air quality regulations, such as emissions regulations, particulate standards and policy, are not generally established for smaller particles.

34. Volatile organic compounds are of concern both because they are highly reactive — they can react with other chemicals in the atmosphere to produce particulates and ozone — and because they are, in varying degrees, directly toxic to human health. Hydrocarbons react with NO_x in sunlight to form ozone (O_3) which interferes with respiratory function, including reduced lung capacity and increased intensity of lung infections. The impacts of long-term and chronic exposure to ozone are unclear, but some evidence suggests "reason for concern". NO_x are also of concern because of their capacity to form ozone, their toxicity to human health (especially NO_2) and their capacity to react in the atmosphere to form greenhouse gases. Carbon monoxide can be released if combustion is incomplete, and CO emissions are often highly correlated with hydrocarbon emissions. Other local pollutants with harmful effects on health include benzene, polycyclic aromatic hydrocarbons, butadiene and aldehydes. Table 2 indicates the emissions of local pollutants arising from the use of vehicles in selected major cities of developing countries and in the OECD region.

C. Land transport

Road transport

35. The adverse effects of activities in the transport sector on the environment are mainly related to road transport. The economic efficiency and environmental quality of large cities are particularly affected by transport based on the massive use of cars, and more recently by the use of motorcycles. Although individual transport has numerous advantages in flexibility, speed, privacy and comfort of travel, it also has an impact on energy consumption and land use. It may be beneficial to separate motor vehicle ownership from motor vehicle use so that the choice of mode per individual trip is not skewed towards the privately owned vehicle, for which a considerable amount is paid at the time of purchase. Also, in many industrialized countries, considerable investment in road transport infrastructure has been instrumental in influencing an array of choices by the public that affect transport demand in the long run. Public transport and non-motorized transport modes emit fewer pollutants per passenger-kilometre, are more economical in their use of transport space than private modes and support higher urban-development densities, with benefits for sustainable development.

36. Development of public transport can lead to the establishment of transport networks made up of diverse modes that are compatible with travel needs and affordable by the entire population. This requires flexible transport development strategies, particularly under conditions of uncertainty concerning the development prospects that prevail in many cities in developing countries. Transport space for the exclusive

Table 1
Status of unleaded gasoline use, by region

Region	*Percentage of countries 100% unleaded*	*Median allowable lead content (grams per litre)*	*Maximum allowable lead content (grams per litre)*
Sub-Saharan Africa	0	0.64	0.84
South and East Asia	6	0.15	0.45
Middle East/North Africa	5	0.6	0.84
Central and Eastern Europe	13	0.15	0.37
Western hemisphere	45	0.025	0.85
Western Europe	25	0.15	0.15
World	16	0.15	0.85

Source: Magda Lovei, "Phasing out lead from gasoline: worldwide experience and policy implications", in *Environment Department Papers*, No. 40 (Washington, D.C., World Bank, 1996), annex 1.

Table 2
Percentage of emissions affecting local areas from vehicles, selected cities and regions, by type of emission

City	*Carbon monoxide*	*Volatile organic compounds*	*Nitrogen oxides*	*Sulphur dioxide*	*Particles*
Beijing	79	75	46	NA	NA
Budapest	81	75	57	12	NA
Cochin	70	95	77	NA	NA
Colombo	100	100	82	94	88
Delhi	90	85	59	13	37
Kathmandu	..	..	..	3	12
Lagos	91	20	62	27	69
Mexico City	100	54	70	27	6
Santiago	92	81	82	25	10
São Paulo	97	89	96	86	42
OECD	70	31	52	4	14

Sources: United Nations and World Bank, *Transport Issues, Options and Strategies for Sustainable Development* (New York, 2001), and OECD data.

Note: Two dots (..) indicate that data are not available.

use of public transport can be created or reallocated from automobiles to public transport, wherever the latter solution is feasible. The use of this space must be adapted to local conditions, reflecting, inter alia, financial affordability of mode installation and operation, its economic viability, its expected impact on the transport network, the sustainability of the urban structure and any socially distributive effects.

37. Buses are likely to retain an essential share of public transport; thus, efforts to improve the operation, maintenance and management practices of bus transport and reduce its contaminant effects and, where feasible, promote the use of electric trolleybuses and trams will enhance efficiency. Also, para-transit can play a substantial role in public transport, in particular in developing countries. Regulation of para-transit by Governments should focus on safety and environmental requirements, while not impeding para-transit operation or limiting entry to the market, with the possible exception of transport corridors that are already heavily loaded and well served by buses.

Rail transport

38. Many countries utilize rail transport for inter-urban as well as intra-urban transport, but reliance on rail has been overshadowed by increased use of road transport. In India, for example, the predominant mode of motorized transport in the 1950s was rail transport. However, by the 1990s, 80 per cent of passengers and 60 per cent of freight were moved by road. This is partly due to the high capital costs associated with rail transport. Rail transport systems have traditionally operated either as public institutions or have received large subsidies in many industrialized and developing countries. Many systems have become inefficient over the years and thus unable to compete with other modes of transport. There has been a move to reorganize and privatize rail transport, and private capital has been attracted to upgrade rails and improve service in some countries. Measures to attract the private sector, including concession agreements, have been adopted in Argentina, Colombia, Morocco, Mozambique, Peru and Poland.

39. High-capacity public rail transport could become indispensable in very large cities with strong and intensively developed centres. These modes are often preferable for environmental reasons, but capital and operating costs are usually prohibitively high. Such modes can only be developed if high economic and environmental benefits can be achieved, and extensive methods of environmental cost/benefit analysis to capture all the cost and benefits are important. Europe and Japan have successfully adopted high-speed rail systems for inter-urban transit, and a new system recently began operating in the United States. Movement of dense commodities, such as coal, agricultural goods and chemicals, is undertaken by rail to a significant level in some countries. In the United States, railroads move 38 per cent of intercity freight, while using 11 per cent of total fuel used to move freight, and railroads have become more productive in recent years. Rail transport has a role to play in many national transport systems, and may contribute to sustainable development goals if cost-effective.

Non-motorized transport

40. In the pursuit of transport policies reflecting sustainable development, the promotion of walking and cycling can be important. The bicycle is by far the most energy-effective means of passenger transport and the most affordable for the urban poor. Adequate provision of safe cycle routes and parking facilities can enhance sustainability in urban transport systems. Similarly, policies to support walking as a prime mode of transport, through the provision and maintenance of walkways, can also be effective in urban areas.

D. Air transport

41. Air transport has experienced rapid growth since the Second World War, with scheduled domestic and international air traffic increasing from 9 million passengers in 1946 to more than 1.5 billion in 1998, or approximately 10 per cent annually. Air transport growth is directly related to economic performance, and demand for air freight service is primarily a function of economic growth and international trade. Air traffic growth has been influenced by improvements of service, reductions in airline fares, increasing trade and the globalization of business, population and income distribution, and travel behaviour. Its rapid growth has stimulated technology innovations that have resulted in increased efficiency and productivity in the industry.

42. Air traffic growth is expected to continue, though at a lower rate. Recent estimates by the International Civil Aviation Organization (ICAO) show domestic traffic growing at an average annual rate of 3.5 per cent

and international traffic growing at 5.2 per cent for the 1998-2000 period. The Intergovernmental Panel on Climate Change (IPCC) projects aviation growth at 5 per cent for the 1990-2015 period, with fuel consumption and CO_2 emissions growing at 3 per cent annually over the same period.

43. Environmental issues associated with air transport include airport noise, air quality near airports, global pollution, construction and expansion of airports and associated infrastructure, water and soil pollution in airport vicinity, management of wastes in airports, and environmental problems arising from aircraft accidents, incidents or emergency procedures. Aircraft produce emissions similar to other fossil fuel vehicles but are unusual in that a significant proportion of the emissions are made at very high altitudes. At the global level, it is estimated that aircraft greenhouse gas emissions contribute about 3.5 per cent of total radiative forcing[6] by all human activities, and that proportion is likely to increase. The emissions from aircraft relevant to climate change include CO_2, water vapour, NO_x, SO_x and soot. These gases and particles are emitted directly into the upper troposphere and lower stratosphere, where they increase the concentration of greenhouse gases, including carbon dioxide, ozone, water vapour and methane, trigger the formation of condensation trails (also known as "contrails") and perhaps increase cirrus cloudiness — all of which are thought to contribute to climate change.

44. Options considered for reducing aircraft emissions include changes in aircraft and engine technology, fuel, operating practices and regulatory and economic measures. Along with ICAO, a number of United Nations bodies are considering the issue of aircraft emissions, including the United Nations Framework Convention on Climate Change, the Montreal Protocol on Substances that Deplete the Ozone Layer and, under the auspices of the Economic Commission for Europe, the Convention on Long-range Transboundary Air Pollution. Efforts have been undertaken among these organizations to cooperate to avoid duplication. ICAO has undertaken efforts to study policy options to limit or reduce greenhouse gas emissions from civil aviation, taking into account the IPCC special report and the requirements of the Kyoto Protocol, and is expected to complete its study in 2001. It focuses on three broad categories: improved technology; new standards and operational measures; and market-based options, including economic instruments to reduce noise and to address the impact of aircraft engine emissions. It is currently identifying and evaluating the potential role of market-based options, including emission-related levies, emissions trading and voluntary programmes, as a means of limiting greenhouse gas emissions. Initially, emissions trading levies, with a focus on fuel taxes, revenue-neutral charges, en-route emissions charges and emissions trading, are under investigation, along with a variety of voluntary programmes.

E. Maritime transport

45. International shipping registered its twelfth year of consecutive growth in 1997, with seaborne trade reaching a record high of 4.95 billion tons (see A/55/61, para. 41). At the end of 1999, the world merchant fleet had reached 777.8 million deadweight tons. Oil tankers and dry bulk carriers continued to dominate the world fleet, representing 66 per cent of total tonnage in 1999. Maritime transport plays an important role in sustainable development, in that it is an essential facilitator of international trade and can thus have a positive impact on economic and social development. Many developing countries are undergoing the liberalization and privatization of their maritime industries as a means of strengthening commercial capabilities of national service suppliers and increasing competitiveness in the maritime services sector.

46. Maritime transport is associated with environmental risks related to fuel emissions, the decommission/recycling/scrapping of ships, spillage of oil and other hazardous and noxious substances, and disposal of wastes at sea. A number of international agreements and protocols have been established to create standards and regulations for pollution in the maritime industry. The International Maritime Organization (IMO) has identified a number of areas related to environment regulation and standards, and follows a proactive policy to identify at the earliest possible stage incidents of environmental damage and to take action to avoid or mitigate such effects. The safety of dry cargo bulk carriers has become an IMO priority in recent years, and in July 1999 new standards and regulations were introduced, and further recommendations relating to the design and

construction of bulk carriers are now under consideration.

47. The IMO Marine Environment Protection Committee deals with the protection of the marine environment, including the issue of recycling of ships. IMO standards and regulations pertaining to marine pollution have been agreed upon under the International Convention for the Prevention of Pollution from Ships (MARPOL) and its protocols. MARPOL, which came into force in 1973 and was modified in 1978, requires owners of older vessels to implement major structural changes according to strict requirements. The International Hydrographic Organization conducts surveys and prepares maps, and has identified geographical regions where coordination and cooperation should be enhanced in the interest of navigation safety and the protection of the marine environment; these include the West Pacific Islands, South Asia, the Persian Gulf, the Red Sea, Southern Africa, Western and Central Africa, the Southern Mediterranean, the Black Sea, and Central America and the Caribbean.

48. The international community has recognized that the sustainable development of oceans and seas is integral to the effective implementation of the United Nations Convention on the Law of the Sea and efforts have been made to promote cooperation in this area (see General Assembly resolutions 54/33, 54/31 and 55/7). The Convention addresses the issue of safe transport, and the IMO Marine Environment Protection Committee agreed to take chapter 19 of Agenda 21 into account in its work on the follow-up to the United Nations Conference on Environment and Development (see MEPC/WP.6/Add.2, paras. 13.9 and 13.10).

IV. Transport technologies

49. There exists potential for an affordable vehicle fleet that maintains environmentally sound standards. Research and development of vehicles that are both fuel efficient and emission reducing, as well as technologies that can be used to upgrade the existing fleet, are becoming more readily available. However, a widespread effort to transfer such technologies to developing countries has not been undertaken on a systematic basis.

A. Rate of change in the vehicle fleet

50. The rate of change of technology in the vehicle fleet depends largely on economic factors, and in most developing countries drivers of old vehicles cannot afford to replace their vehicles with newer models. Two major strategies that can lead to greater change in technology in the fleet are the encouragement of vehicle turnover and vehicle retrofitting. Vehicle turnover can be stimulated by incentives, including tax breaks and programmes for old vehicle recycling, though buying new vehicles may prove too costly for the majority of buyers in developing countries, even with added economic incentives. Vehicle retro-fitting often involves addition or replacement of the fuel system in order to facilitate use of alternative fuels, such as compressed natural gas, liquefied natural gas or an alcohol fuel. Retrofitting is easier to accomplish on fleet vehicles than on individually owned vehicles, so such strategies often start by targeting public transport, urban freight delivery and corporate fleets.

B. Maintenance of vehicles

51. High emissions from older vehicles are largely due to poor maintenance of vehicles. The positive effect of proper maintenance has been shown through a number of studies. Although better fuel economy provides an incentive for periodic maintenance of vehicles, many vehicle owners in developing countries simply do not have the resources to undertake extensive repairs other than what is necessary to keep the vehicles operational. In some instances, they may have the capital but judge that other investments (such as purchasing additional vehicles for their fleets) are more beneficial than investing in increased fuel economy.

C. Fuel technology currently in use

52. A further problem in current transport technology is the continuing use of poor quality fuels. Lead is often added to gasoline as an inexpensive way of raising the octane level on motor fuels, though other options are available at slightly higher cost. In the absence of directed public policy focusing on lead, industry has no incentive to move towards other means of enhancing octane, even though the cost of lead emissions on the environment and in terms of health

are quite high. Furthermore, the presence of lead in gasoline can greatly impede the diffusion of catalytic exhaust treatment, causing emissions of localized pollutants to be higher than otherwise.

53. Another pollutant commonly found in fuel is sulphur. Like lead, sulphur in fuel is both a source of emissions and can neutralize catalytic exhaust treatment. Unlike lead, sulphur is prevalent in diesel as well as gasoline, although it is not added to either. Rather, it is present in varying quantities in different crude petroleum stocks. Refining processes can remove sulphur from fuel but doing so significantly raises production costs. A further problem, often found in developing countries, is fuel adulteration and cross-border smuggling. In certain areas, it is not uncommon to mix kerosene into gasoline or diesel fuel, because of the relative difference in costs. Kerosene has excellent combustion characteristics, is readily available for cooking and heating and is generally untaxed. Any successful programme for pollution control would therefore have to address issues of vehicle technology as well as fuel quality.

D. Alternative fuel vehicles

54. Near-term alternative vehicle and fuel technologies include those utilizing compressed natural gas (in certain applications), liquefied natural gas, hybrid-electric, and in some countries ethanol and methanol. Longer-term options include compressed natural gas in more general applications, battery and fuel-cell electric vehicles, and various synthetic diesel and diesel-substitute fuels. In the very long-term, fuel-cell vehicles fuelled by hydrogen electrolysed by solar energy or possibly solar-powered vehicles are possible.

E. Other emission-reducing technologies

55. There are a number of technologies which are readily available for use in the vehicle fleet that do not involve alternative fuel sources. Industrialized countries have developed mechanisms by which engines are balanced to run more efficiently, thus reducing pollution, but they are often quite expensive. Interim technologies are available to help improve various factors of engine design and move towards lean-burn combustion, including the use, design and timing of fuel-injection systems, the physical design of the combustion chamber and pistons, and exhaust-gas recirculation techniques. This last technique is particularly important for two-stroke engines, where unburned hydrocarbons are plentiful in the exhaust. It also helps to boost overall energy efficiency. For diesel engines, turbocharging is an effective means of increasing oxygen content in the air-fuel mix, reducing emissions. Improvements to emissions performance can be achieved with even more basic improvements to engine design, including modification of carburetor design to optimize air/fuel mixture while controlling NO_x through retarding ignition timing and recirculating exhaust gas. Other technologies include filtration; improvements in the transmission system; and fuel supply/crankcase treatment.

F. Importance of transfer of technology

56. The majority of the clean fuel and alternative vehicle technologies discussed above are predominantly available in industrialized countries. Although such countries as Brazil have experimented with alternative fuels, such as ethanol, the lack of a widespread global commitment to a shift in fuel use has made such efforts costly. The development of alternative vehicles requires significant capital investment for research and design that is unavailable in most developing countries. Gases and particulates can cross borders and affect other countries, irrespective of how "clean" they strive to be, and both industrialized and developing countries may be able to work in partnership to diffuse the knowledge and technology required to attain acceptable levels of emissions while maintaining a feasible level of expenditure.

V. Recommendations

A. National level

57. A wide range of policy options are available at the national level, including those aimed at comprehensive urban planning, which take into account transport needs and sustainable development goals; rural development plans, which aim to promote sustainable development in all sectors, including transport, and which stem migration from rural areas to urban areas; those that recognize the link between poverty and transport so that measures taken to reduce poverty take into account the mobility needs of the

poor; and social development policies that address the relationship between gender equality and access to transport as well as the specific transport needs of women.

58. Policy options for promoting sustainable development specific to the transport sector include those aimed at incorporating sustainability criteria in transport infrastructure investment decisions. National Governments may also wish to consider adopting measures to:

- Promote the incorporation of purchase cost into operating costs of private vehicles, so that the vehicle purchase cost does not greatly influence the choice of mode per trip. Such measures could include those aimed at affecting costs related to parking, fuel, insurance and road use;
- Encourage the involvement of the private sector in appropriate areas of transport to promote efficiency and thus reduce emissions;
- Educate the public on the effects of mode choice on the environment at the local and global levels;
- Initiate training programmes for drivers of trucks and fleet operators;
- Encourage the use of information technology in the transport sector, where appropriate;
- Work towards establishing comprehensive transport databases for use by policy makers.

59. Further, national Governments may also wish to consider, as appropriate, specific policies to limit emissions, including:

- Inspection and maintenance programmes;
- Standards and regulations, especially in highly polluted areas;
- Restrictions on or emissions standards for the import of second-hand vehicles;
- Investigation of the possibility of utilizing economic incentives and disincentives to promote the use of cleaner technologies.

60. Governments may also consider adopting aggressive initiatives at the national level to phase out the use of leaded gasoline as soon as possible.

B. Regional level

61. At the regional level, a number of options are available to promote sustainability in the transport sector, including the coordination of policies and measures for establishing guidelines and/or standards for emissions, infrastructure development projects, particularly those with a regional focus, and projects pertaining to sea shipping and the airline industry. The regional commissions should continue to play an active role in coordination and cooperation on transport, with a stress on its role as a key factor in achieving sustainable development.

62. Cooperation at the regional level on improving data collection, compilation and analytical capabilities and methodologies in the transport sector may be beneficial for many regions. This is especially important in areas where cross-boundary pollution is a problem and opportunities exist to cooperate on measures and standards.

63. Regional development banks and financing institutions may wish to consider financing and/or co-financing transport projects in line with sustainable development goals.

64. There is a special need for coordination and cooperation in Africa on transport issues, projects and policies within the context of sustainable development.

C. International level

65. The international community has an important role to play in promoting and enhancing the effectiveness of policies and measures undertaken to achieve sustainable development in the transport sector. Cooperation at the international level has already emerged in a number of international arrangements, conventions and protocols, and is especially important in the areas of maritime transport and air transport. These mechanisms should be continued and strengthened where needed.

66. Cooperation at the international level helps efforts to promote the transfer of technology from industrialized countries to developing countries in the transport sector. This is particularly relevant as new technologies emerge that have less adverse impacts on the environment. International cooperation has a special role to play in the transport sector given its importance in intraregional, interregional and

international trade and as a potential driving force for economic development.

67. The international community may wish to consider the following options aimed at promoting sustainable development in the transport sector:

(a) *Financing*. Since the implementation of strategies to promote sustainable development goals in the transport sector are unaffordable in many developing countries, the international community may wish to consider special measures to ensure that adequate financing is available for the transfer of cleaner technologies, the promotion of energy efficiency, improving the effectiveness of mass transit, the elimination of leaded gasoline and/or other issues deemed a high priority by the international community. Special funding arrangements might be considered, whereby transport measures and programmes to promote sustainable development could be established or incorporated as part of existing funding mechanisms. This would address a pressing need in current arrangements since established funds often overlook the transport sector or give it low priority;

(b) *Information*. The availability of information related to the transport sector is important for decision makers undertaking policies and measures related to sustainable development at the national level, as well as for coordination and cooperation efforts at the regional and international levels. Thus, efforts to assist in capacity-building, improving capabilities to collect, compile and assess and analyse transport-related data according to the most advanced methodologies and using up-to-date information technologies, would be a step forward. There now exist real possibilities for coordination and cooperation given the recent improvements in information technology and the widespread use of the Internet. But basic transport-related information is often unavailable, especially in developing countries. Training and upgrading of capabilities in transport information and information technology as well as capacity-building at the institutional level are areas that merit serious attention by the international community;

(c) *Private/public partnerships*. The private sector has traditionally been involved in the transport sector, and its role is increasing as restructuring is undertaken in both industrialized and developing countries. It may be appropriate for the international community to encourage partnerships among the private sector, Governments and civil society so that all actors in the transport sector work together to achieve sustainable development. Private/public partnerships can be instrumental in facilitating a transfer of cleaner technologies from industrialized countries to developing countries;

(d) *Special measures aimed at Africa and least developed countries*. Given the vital role of the transport sector in facilitating socio-economic development and the high demand for transport traditionally met by animal power and walking, the international community has put special priority on assistance to Africa in global programmes and efforts related to transport. In fact, as Africa as a region and individual African and least developed countries work to improve and expand their transport systems, assistance to promote policies and measures in line with sustainable development goals would be timely. Individual transport projects and/or a comprehensive regional assistance programme aimed at the transport sector could be built on such initiatives as the current United Nations/World Bank Global Initiative on Transport Emissions (see annex);

(e) *Phasing out of leaded gasoline*. The international community needs to follow up on its commitment to phase out leaded gasoline, as called for by the Commission on Sustainable Development at its third session, in 1995, and recommended by the General Assembly at its nineteenth special session, in 1997, with specific support to assist developing countries in achieving this goal. Such assistance could include financial and technical assistance to promote the reformulation of gasoline at national refineries in the form of low-interest loans, grants and/or co-financing, as well as the provision of technical support, where needed;

(f) *Elaboration of a comprehensive, international action programme aimed at sustainable development in the transport sector*. Consideration could be given to the elaboration of an international action programme, involving international organizations, governments and major groups, that could promote sustainable development in the transport sector. Such a programme could be built on such initiatives as the Global Initiative on Transport Emissions (see annex). It could incorporate the options discussed in the present report, specifically financing, transport information and private/public partnerships, in a coordinated way that would promote cooperation

among industrialized and developed countries to reduce adverse environmental impacts from the transport sector while promoting socio-economic development. The programme of work could focus on regional and national training workshops on transport information; round-table meetings at the regional level to promote partnerships between vehicle and fuel manufacturers and consumers in developing countries and countries with economies in transition; and funding of sustainable development projects, with a focus on small and medium-sized businesses.

Notes

[1] See report of a United Nations international round table on transportation energy efficiency and sustainable development, Cairo, December 1999, annex II, accessed at *http://www.un.org/esa/sustdev/gite/teesd-report.pdf*.

[2] For a detailed analysis of how transport affects the poor, see UNDP, *Draft Interim Report on Transport and Sustainable Human Settlements: A UNDP Policy Overview* (2000), chap. III.

[3] Ibid., chap. V.

[4] See ibid.

[5] Bahrain, Egypt, Jordan, Iraq, Kuwait, Lebanon, Oman, the Palestinian Authority, Qatar, Saudi Arabia, the Syrian Arab Republic, the United Arab Emirates and Yemen.

[6] "Radiative forcing" is a measure of the importance of a potential climate change mechanism.

Annex

Global Initiative on Transport Emissions

I. Background and objectives

The Global Initiative on Transport Emissions (GITE) is a project undertaken jointly by the World Bank and the United Nations, in cooperation with the private sector, to facilitate cooperation among automotive and petroleum industries and developing countries and relevant international agencies in order to promote energy efficiency in the transportation sector, reduce local and global environmental problems, contribute to a more sustainable use of energy and contribute to sustainable development in the developing world. GITE aims to promote an expanded application of knowledge and technology to the transportation sector to facilitate a reform process; the better utilization of energy in the transportation sector; the protection of the environment by reducing emissions from motor vehicles and improving air quality through, inter alia, the promotion of knowledge and rational use of alternative fuels and alternative fuel vehicles; a better understanding of transportation energy consumption/production issues, including consumer awareness; and the integration of transportation and land use planning and their impacts on energy use.

II. GITE structure

The Global Initiative on Transport Emissions (GITE) comprises three programmes: the Transport Emissions Knowledge Initiative (TEKI); the Partnership for Vehicle and Fuel Technology Modernization (PVFTM); and the Small Initiatives Clearinghouse (SIC). The chart below shows key components of GITE and its linkage with other entities, such as national Governments, domestic automotive and fuels industries, international agencies, strategic business partners and financial institutions which could fund individual projects.

III. Transport Emissions Knowledge Initiative

The TEKI programme works with national Governments and international agencies to develop an adequate information base, assist in strengthening national institutions responsible for policy formulation and coordinate with relevant international agencies.

Objectives

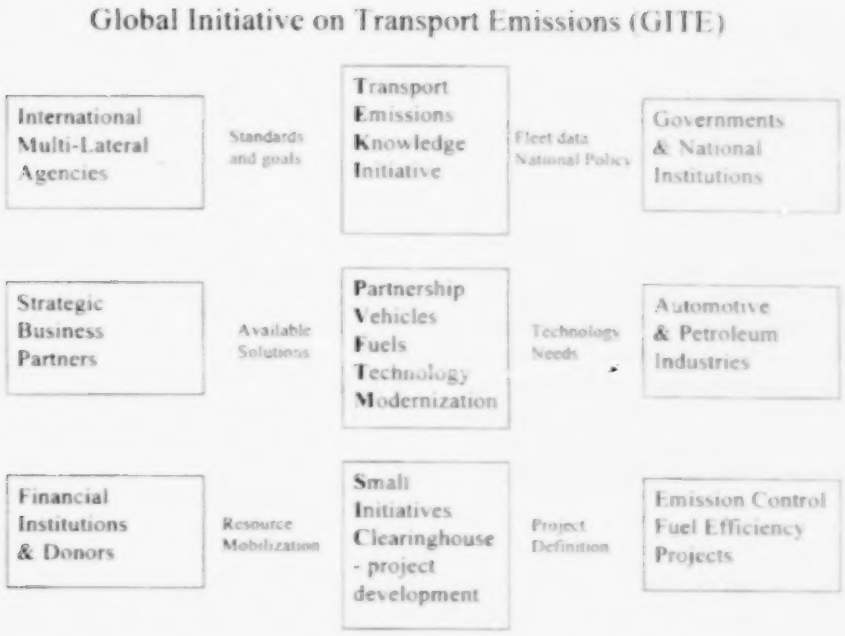
- To facilitate development of institutional structures and human capital in developing countries to gather, analyse and use transport emissions and energy use data.
- To strengthen policy formulation in relation to the automotive and fuels industries, transport emissions control and transportation demand management.
- To work with other international agencies on matters related to transport emissions.

Principal activities

1. Development of national transport energy consumption and emissions models to enable effective, policy-oriented analysis of transport energy demand.

2. Regional workshops on transport emission standards, indicators and policy formulation to discuss conceptual issues and policies related to transport emissions.

3. Development of a TEKI web page to provide a forum for discussion of transport emissions policy, publish best practice examples and provide basic information on transport and energy use in developing countries as it becomes available.



IV. Partnership for vehicle and fuel technology modernization

PVFTM is a consortium of strategic business partners comprising participating multinational auto manufacturing and petroleum companies who are willing to enter into technology-sharing arrangements with developing country industries. PVFTM will assist in identifying technology needs and matching them with available solutions.

Objectives

- To exchange information and develop plans to upgrade technologies of motor vehicle manufacturing, maintenance and operations in developing countries in order to reduce transport emissions, energy intensity and mobile source air pollution.
- To enable dialogue among vehicle manufacturers and fuel refiners with primary markets in developing countries, those with primary markets in developed ones, and policy makers in order to improve the quality of transportation fuels in developing countries.

Principal activities

1. Background report on automobile manufacturing in and for developing countries.
2. Background report on fuel refining, storage and distribution in developing countries.
3. Round tables of vehicle manufacturers, fuel companies and policy makers.
4. PVFTM web page.

V. Small initiatives clearinghouse

The SIC programme is intended to identify and define small projects, to be implemented by private sector interests or by national Governments, which introduce new technologies or undertake other actions that reduce transport emissions. The programme would work with project sponsors to develop projects for presentation to potential financing agencies and seek to identify suitable financing mechanisms.

Objectives

- To provide a single resource for information on small initiatives.
- To identify and develop specific projects to the concept stage and advise on financing mechanisms.

Principal activities

The primary purpose of SIC will be to collect and disseminate information on pilot and other small projects being undertaken in developing countries around the world on various aspects of transport energy and emissions reduction. This effort should aim to be as comprehensive as possible, and would include activities undertaken by GITE participants. Specific initiatives that may require financing will be developed into project concepts and presented to suitable financial institutions.